Spur and Helical Gear Tooth Forces from Power and Speed

Tangential, radial and axial forces on spur or helical gear teeth from the power, speed and pitch diameter, with pressure angle and helix angle, for bearing loads.

Method: Shigley's Mechanical Engineering Design (Budynas and Nisbett); ch. 13 (W_t = 2T/d, W_r = W_t tan φ_n / cos ψ, W_a = W_t tan ψ)

Input parameters

Unit system: SI

Parameter	Value	Unit
Power transmitted	15.000	kW
Speed of the gear	1,440.0	rpm
Pitch diameter	80.000	mm
Normal pressure angle	20.000	°
Helix angle (0 for spur gears)	0	°

Calculated results

Parameter	Value	Unit
Torque on the gear	99.472	N·m
Tangential force	2.4868	kN
Radial (separating) force	0.90512	kN
Axial (thrust) force	0	kN
Total tooth force	2.6464	kN
Pitch line velocity	6.0319	m/s

Formula and method

$$W_t = \frac{2T}{d}, \quad W_r = W_t \frac{\tan \phi_n}{\cos \psi}, \quad W_a = W_t \tan \psi$$

Variables

P	Power transmitted	W
n	Speed of the gear	1/s
d	Pitch diameter	m
ϕ_n	Normal pressure angle	rad
ψ	Helix angle (0 for spur gears)	rad
T	Torque on the gear	N·m
W_t	Tangential force	N
W_r	Radial (separating) force	N
W_a	Axial (thrust) force	N
W	Total tooth force	N
v	Pitch line velocity	m/s

Method and standards

Resolution of the normal tooth force.

Assumptions and limits

- Friction neglected.

References

- Shigley's Mechanical Engineering Design (Budynas and Nisbett)
- ch. 13 ($W_t = 2T/d$, $W_r = W_t \tan \varphi_n / \cos \psi$, $W_a = W_t \tan \psi$)

Report details

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Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/mechanical/machine-design/spur-gear-forces

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.